SPRINGS AS INDICATORS OF THE ECOLOGICAL CONDITION OF THE ENVIRONMENT (A STUDY OF ROSTOV ON DON)

FUENTES COMO INDICADORES DEL ESTADO ECOLÓGICO DEL MEDIO AMBIENTE (UN ESTUDIO DE ROSTOV DEL DON)

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ABSTRACT

Springs are one of the essential part of water suppling system in Rostov on Don. Nearly 60 springs are known to exist in the city. Rostov region is located in the arid climate zone, where there are limited natural resources of fresh groundwater. At the same time, region due to the regional hydrogeological relation is situated at the junction of four artesian basins in their regional parts focused significant resources of fresh pressure water. Springs and wells in Rostov on Don are pumped from the Azov-Kuban aquifer system. From the hydrogeological point of view, the most important is Sarmatian aquifer, which is 10 m, and in certain parts of the aquifer area even 30 m thick. Groundwater has mottled mineralization and chemical composition. The chemical composition of water complex hydrocarbonate, chloride-sulfate and sulfate-chloride. Hydrogeological, environmental and landscape studies, chemical analysis of spring water for 24 components a brief field study of water, composed of the passport illustrated with photos were carried out. Mainly springs has temperature in the range of 10° - 14°C. The water is generally hard. Main contamination of groundwater is connected with nutrients, especially nitrate concentrations. Groundwater in city does not coincide with standards for drinking purpose.

KEYWORDS: springs, Russia, groundwater monitoring, nitrate, water hardness
1. INTRODUCTION

Springs provide a way to assess groundwater quality because their discharge integrates groundwater from large parts of the aquifer. They are a reflection of the state of groundwater and influence surface water directly, including all ecosystems.

Springs were vital to the survival during many centuries. They have played an important part in cultural and economic history, as first settlements appeared near sources of water because of their ability to supply people with clean freshwater. Throughout the 1990’s, water quality problems and increased demand for water have renewed interest in springs in Russia.

Thousands of springs lie within Rostov region in the South of Russia. Some springs are isolated or clustered into groups, varying size, and areal extent. In Rostov on Don can be found more than 60 springs.

2. MATERIALS AND METHODS

Rostov-on-don located in the south of Russia within Severopriazovskaja plain on the right bank of the river Don. The average altitude is 85 m, the highest - 115 m. The plain is composed of marine Neogene (Sarmatian, Meiotic, Pontian) sediments, covered by Quaternary loess-like loams. The lack of rivers and streams results from a well-developed underground drainage system in the limestone.

Fig. 1. Location of the study area

Rostov region is located in the arid climate zone, where there are limited natural resources of fresh groundwater. At the same time, region due to the regional hydrogeological relation is situated at the junction of four artesian basins in their regional parts focused significant resources of fresh pressure water. Main unconfined aquifers have a limited distribution because they associated with areas closer to surface water sources (major rivers, reservoirs). Whereas surface water is often
contaminated. Thus, it is important to assess springs for water supply. On the territory of the Rostov region presented artificial and natural springs. In general, natural exits of underground waters dominated in the region[1].

Springs and wells in Rostov on Don are pumped from the Azov-Kuban aquifer system. From the hydrogeological point of view, the most important is Sarmatian aquifer, which is 10 m, and in certain parts of the aquifer area even 30 m thick. It is associated with Haprovsky sand, Meiotic and Sarmatian limestones, and underlying Sarmatian sands. The aquifer is free-flow or weak pressure. This aquifer is confined the springs of Rostov on Don. Most of the high capacity is the springs in the Botanical garden (flow rate up to 120 l/s), Bogatyanovsky (flow rate of 50 l/s). Recharge of groundwater is done through discharge from other aquifers. Discharge occurs in the valleys of the river Temernik and Don as springs.

Groundwater has mottled mineralisation and chemical composition. The chemical composition of water complex hydrocarbonate, chloride-sulfate and sulfate-chloride.

3. RESULTS

The research was conducted in the area of more than 1 million inhabitants and includes 90 wells and 60 springs. Hydrogeological, environmental and landscape studies, chemical analysis of spring water for 24 components a brief field study of water, composed of the passport illustrated with photos were carried out. Mainly springs
have temperature in the range of 10° - 14°C.

Table 1 The results of chemical analyses of water from the most popular springs, Rostov on Don

<table>
<thead>
<tr>
<th>№</th>
<th>Spring</th>
<th>S0₄ 66HCO₃</th>
<th>24Cl 10</th>
<th>M₂,7</th>
<th>pH7,8 t°C10</th>
<th>Na40 Ca32</th>
<th>Mg28</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surb-Khach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Monastery</td>
<td>SO₄ 66</td>
<td>HCO₃ 22 Cl 12</td>
<td>M₂,8</td>
<td>pH7,2 t°C12</td>
<td>Ca 42 Mg31</td>
<td>Na 27</td>
</tr>
<tr>
<td>3</td>
<td>Botanicalgarden</td>
<td>SO₄ 76 Cl 20</td>
<td>HCO₃ 4</td>
<td>M₃,2</td>
<td>pH8,1 t°C11</td>
<td>Na46 Mg30</td>
<td>Ca24</td>
</tr>
<tr>
<td>4</td>
<td>Gremuchy</td>
<td>SO₄ 67 Cl20</td>
<td>HCO₃ 13</td>
<td>M₃,7</td>
<td>pH7,6 t°C11</td>
<td>Na 49 Ca 28</td>
<td>Mg24</td>
</tr>
<tr>
<td>5</td>
<td>Pervomaysky</td>
<td>SO₄ 68 Cl20</td>
<td>HCO₃ 12</td>
<td>M₃,1</td>
<td>pH7,8 t°C11</td>
<td>Na 44 Ca 32</td>
<td>Mg24</td>
</tr>
</tbody>
</table>

There are two classifications of water for the level of hardness. One classification of drinking water with total hardness less than 4 mmol/dm³ characterised as soft, 4 to 8 mmol/dm³ - medium hardness, from 8 to 12 mmol/dm³ - hard, more than 12 mmol/dm³ - very hard. According to another classification (O. A. Alehin): very soft - to 1.5 mmol/dm³, soft -1.5 - 3.0 mmol/dm³, moderately hard - 3.0-6.0 mmol/dm³, hard - 6.0-9.0 mmol/dm³, very hard - more than 9.0 mmol/dm³ [2].

In terms of water hardness, the water is generally hard. The study of the hardness of water in springs of RostovonDon shows that non-carbonate hardness (permanent) prevail. The constant use of water of increased hardness leads to the accumulation of salts in the body, the accumulation of...
stones in the kidneys, disease of the joints. It also leads to the deformation of heating systems and domestic appliances. This problem is especially relevant for regions with a high permanent hardness of water, where it is necessary to control this parameter [3-5].

Table 1 The value of hardness of the water in the springs, Rostov-on-Don (mmol/dm$^3$)

<table>
<thead>
<tr>
<th>Spring</th>
<th>Surb-Khachan</th>
<th>Monaster</th>
<th>Watervallel</th>
<th>Botanic garden</th>
<th>Pervomaysk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total hardness</td>
<td>23</td>
<td>29.2</td>
<td>32.0</td>
<td>27.0</td>
<td>24.81</td>
</tr>
<tr>
<td>Carbon hardness</td>
<td>5.8</td>
<td>8.2</td>
<td>5.6</td>
<td>2.3</td>
<td>6.4</td>
</tr>
<tr>
<td>Non-carbonate hardness</td>
<td>17.2</td>
<td>21.0</td>
<td>26.4</td>
<td>24.7</td>
<td>18.41</td>
</tr>
</tbody>
</table>

Calcium and magnesium values are typically in the range of 252 - 344 mg/l and 126 - 279 mg/l, respectively, and carbonate concentrations usually vary between 140 and 500 mg/l.

The pH value fluctuates slightly from 7.4 to 7.8, which is typical for waters with a high content of hydrocarbons. It is characterised by excessive concentrations of nitrates.

Main contamination of groundwater is connected with nutrients, especially nitrate concentrations. Of particular note are the springs along the creek in the central part of the city. Nitrates in the water exceed the maximum permissible concentration of 9.6 times. Virtually the entire stream...
channel microbiological indicators inflated in $10^3$ times.

4. CONCLUSION

Increased anthropogenic activities, like development and water use, can cause changes in spring water chemistry and spring flow. Among main problems that exist in Rostov on Don is the problem of water hardness and nutrients in the water. Nutrient enrichment of springs, specifically by nitrate and phosphorus, is a major issue due to the potential eutrophication of their receiving waters (rivers, and estuaries). Measured nitrate concentrations at some springs exceed the drinking water standards and are potentially dangerous to the population.

Since most springs are used for domestic purposes and water supply, they need to be better protected against pollution from human activities. A continuous monitoring of groundwater quality at selected sites, in particular for nitrate and microorganisms, should be established.

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REFERENCES


**SOBRE LOS AUTORES**

Olesya Nazarenko profesor Titular del Instituto de Ciencias de la Tierra de la Universidad Federal de Rostov, Rusia, colabora, participa como investigadora en varias redes profesionales.